

Modified Signage and Pavement Markings  
Requiring Vehicles to Stop Behind Light Rail  
Vehicles Stopped to Board or Alight  
Passengers

**Final Evaluation Report**

CTCDC Experiment 16-07

**Submitted to:**

California Traffic Control Devices Committee

**Submitted by:**

San Francisco Municipal Transportation Agency

March 2018

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## Executive Summary

The San Francisco Municipal Transportation Agency (SFMTA) received permission from the California Traffic Control Devices Committee (CTCDC) on March 3, 2016 to install modified signage and pavement markings as a way to improve the compliance rate of vehicles stopping behind a light rail vehicle (LRV) that is stopped to board and alight passengers. The impetus behind the experiment was to identify a quick and cost-effective treatment that would improve the safety for passengers boarding and alighting LRVs: 22 vehicle-pedestrian collisions occurred involving alighting and boarding passengers in a five-year period between 2009 and 2013 along the Taraval Street corridor in San Francisco.

The experimental treatments were installed in April 2017 at five inbound transit stop locations and were evaluated for a period of six months. The effectiveness of the treatments was evaluated based on the rate of driver compliance in stopping behind trains that are stopped and have their doors open to board or alight passengers, obtained through recorded video footage.

In fall 2016, before the experimental treatments were installed, 72% of vehicles stopped behind the train when doors were open. SFMTA aimed for an increase of compliance to 90%; if compliance improved to 90% the measures would be considered successful and SFMTA would not implement the standard treatment of concrete boarding islands at these locations.

The final compliance rate improved marginally with the treatments, achieving a compliance rate of 74%. There were no reported collisions at these five experiment locations during the six-month study period, but given lack of improvement in driver compliance, SFMTA does not consider the experiment successful and does not recommend that the CTCDC adopt the experiment. Based on the results of this evaluation, these transit stops on Taraval Street will have a boarding island installed as part of a future construction project.

## Background

SFMTA oversees the surface transportation system in San Francisco, including operation of the San Francisco Municipal Railway (Muni). Muni operates five transit modes (motor coach bus, electric trolley bus, cable car, historic streetcar and light rail). There are six light rail lines, all of which serve a combination of surface streets and an underground subway. Of the six light rail lines, only the L Taraval line boards and alights passengers through a live lane of traffic without any protection from vehicles through either a boarding island or a transit sidewalk bulb-out at a majority of transit stops.

The L Taraval line carries 29,000 passengers per day and operates along a 2.7-mile surface segment in each direction, in addition to a subway segment. The majority of the surface segment is on Taraval Street, which is 60 feet wide, with 2 travel lanes in each direction and parking on each side of the street. The LRVs travel on the inside lane of each direction and board/alight passengers from/to the curb lane. There are no established protected passenger facilities on Taraval Street such as boarding islands or transit sidewalk bulb-outs at 23 of the 27 surface transit stops. San Francisco is the only city in California that has passengers board and alight an LRV from an active traffic lane, which is a holdover from Taraval Street's history as a streetcar line with much lower traffic volumes. As a result, this problem is unique to this jurisdiction.



Figure 1. Aerial of Taraval Street (via Google Maps)

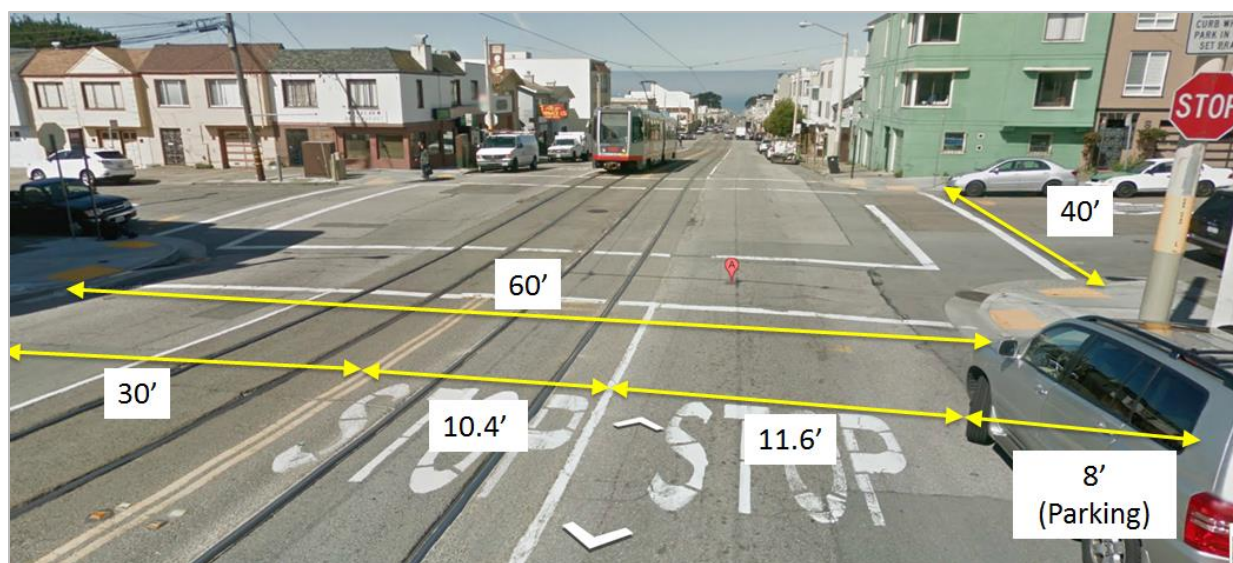


Figure 2. Taraval Street Lane Configuration, looking west (via Google Maps)

In the past five years of available data (2012-2016), there were 35 total collisions between vehicles and pedestrians along the surface line of the L-Taraval. Twenty of these collisions occurred when a person was either boarding or alighting the LRV. These numbers are updated from the Request to Experiment document reported values from 2009-2013 of 45 total collisions between vehicles and pedestrians – 22 involved boarding/alighting a LRV. None of the collisions were fatal, but all included some level of reported injury.

The boarding/alighting vehicle-pedestrian collisions occurred despite an existing California Vehicle Code (CVC) that regulates vehicle behavior during the presence of LRVs. CVC Section 21756 states:

- (a) The driver of a vehicle overtaking any interurban electric or streetcar stopped or about to stop for the purpose of receiving or discharging any passenger shall stop the vehicle to the rear of the nearest running board or door of such car and thereupon remain standing until all passengers have boarded the car or upon alighting have reached a place of safety, except as provided in subdivision (b) hereof.
- (b) Where a safety zone has been established or at an intersection where traffic is controlled by an officer or a traffic control signal device, a vehicle need not be brought to a stop before passing any interurban electric or streetcar but may proceed past such car at a speed not greater than 10 miles per hour and with due caution for the safety of pedestrians.
- (c) Whenever any trolley coach or bus has stopped at a safety zone to receive or discharge passengers, a vehicle may proceed past such trolley coach or bus at a speed not greater than 10 miles per hour.

Specifically, section (a) applies to Taraval Street, where the vast majority of stops do not have a safety zone.

To improve vehicle compliance with CVC 21756(a), the CTCDC approved SFMTA's Request to Experiment with Modified Signage and Pavement Markings on March 3, 2016 (Item 16-07).



## Experimental Treatments

The experiment was to improve compliance of CVC 21756(a) by using modified signage and pavement messages requiring vehicles to stop mid-block behind a LRV that is stopped to board or alight passengers where no safety zone exists.

The details of the experimental treatments are as follows:

- (1) **Modified Signage** – A new sign was created from the combining existing signs (R15-5 and R10-6) and adding “STATE LAW” and the CVC section 21756(a). The dimensions of the sign are 30” wide and 48” tall. Refer to Figure 3 for a photo of the sign.



Figure 3. Experimental Sign

- (2) **Pavement Markings** – a 12” solid white limit line was painted approximately 150 feet upstream of the transit stop to match the length of the typical LRV configuration (2-car trains). The words “TRANSIT BOARDING AREA” were painted with each letter sized at 6’ tall by 1’ wide (the maximum height to fit within the width of the #2 travel lane). Refer to Figure 4.



Figure 4. New Pavement Markings

Figure 5 shows all the experimental treatments (circled in red) adjacent to a stopped LRV.



Figure 5. Experimental Treatments

## Experiment Locations

SFMTA tested the experimental treatments at locations where no collisions involving boarding or alighting passengers occurred during the five-year study period from 2009 to 2013. The evaluation was only tested at locations with fewer than 300 train alightings per day. Stops with more alightings have an increased risk, as most collisions involve people stepping off the train, versus boarding it. The evaluation also focused on commercial areas, given the higher demand for customer parking, which warranted considering this alternative approach that would preserve parking. In total, five inbound stops met these criteria: Taraval Street at 26<sup>th</sup>, 30<sup>th</sup>, 32<sup>nd</sup>, 35<sup>th</sup>, and 40<sup>th</sup> Avenues.

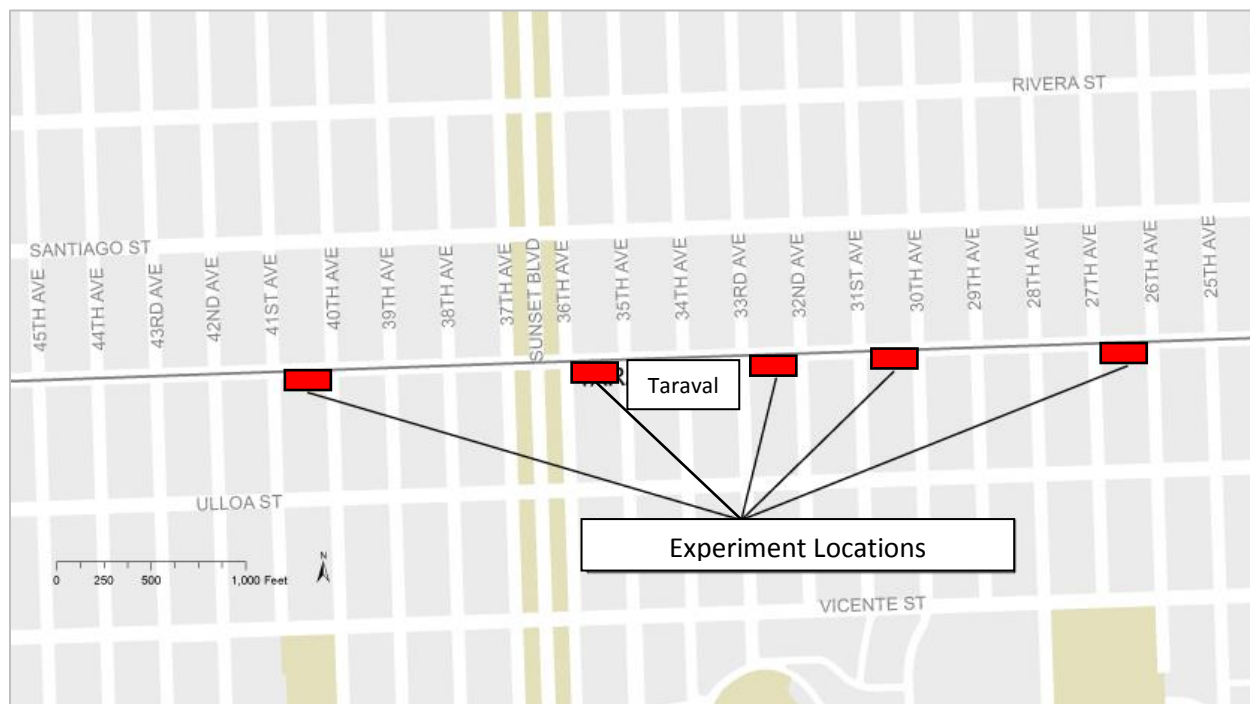


Figure 6. Map of Experiment Locations

No outbound (westbound) stops were included because the risk to passengers is generally higher due to higher volumes of passengers alighting. Thus we recommended a permanent solution of installing boarding islands to address injury concerns for all outbound stops, as well as several higher-use inbound stops or stops with a history of at least one collision in the past 5 years. Boarding islands would also be implemented at the five experiment locations if the compliance rate did not increase to a satisfactory level.



## Evaluation Methodology

The new signage and pavement markings were installed by SFMTA crews and were completed in April 2017. The evaluation period of the experiment was for six months between April and September of 2017.

The effectiveness of the treatments was evaluated based on the rate of driver compliance in stopping behind trains that are stopped and have their doors open to board or alight passengers. Vehicles must have been fully stopped behind the limit line the entire time that the doors were open for the observation to be marked as compliant. If the vehicle made a full stop while the doors were open but then proceeded forward before the doors are closed, the observation was marked as non-compliant.

For each of the five evaluation locations, at least 100 observations were collected in May 2017 and for the final observations in September 2017. Staff reviewed video camera footage from cameras that were mounted at each transit stop for one week to gather 500 observations for both periods, collecting over 1,000 observations in total.

## Results and Analysis

In fall 2016, before the experimental treatments were installed, 72% of cars stopped behind the train when train doors were open. The experimental treatments were installed in April 2017. In May 2017, preliminary data was collected to provide a reference check on how the evaluation was functioning. The compliance rate improved from 72% to 75% one month after implementation.

The target compliance rate was set at 90% through community input and approval of the SFMTA Board of Directors (the governing body that oversees SFMTA). The final results of the evaluation in September 2017 showed a final compliance rate of 74%, which was 16 percentage points below the target compliance rate.

After the preliminary data collection period showed minimal improvements in compliance, staff sought other measures to enhance compliance. The addition of portable variable message signs (VMS) at three of the five locations in September 2017, near the end of the final data collection period, provided an additional, highly-visible warning to drivers to stop behind the train when the doors are open. To see if the VMS signs improved the compliance rate, staff analyzed video footage for days before and after VMS installation at the 30<sup>th</sup> Avenue stop to get a sample size of 100 observations for each configuration. The resulting data showed only a two percentage point increase in compliance when VMS signs were present, despite their high visibility to drivers. The evaluation was also paired with an education campaign that involved sharing safety posters with local merchants to post in their windows, as well as upgraded stickers on the back of all SFMTA LRVs warning drivers to stop, and new, larger lights on the back of trains that flash when the doors are open.

Figure 7 on the next page shows a chart summarizing the compliance rates before the experimental treatments were installed (October 2016) and six months after the experimental treatments were installed (September 2017).

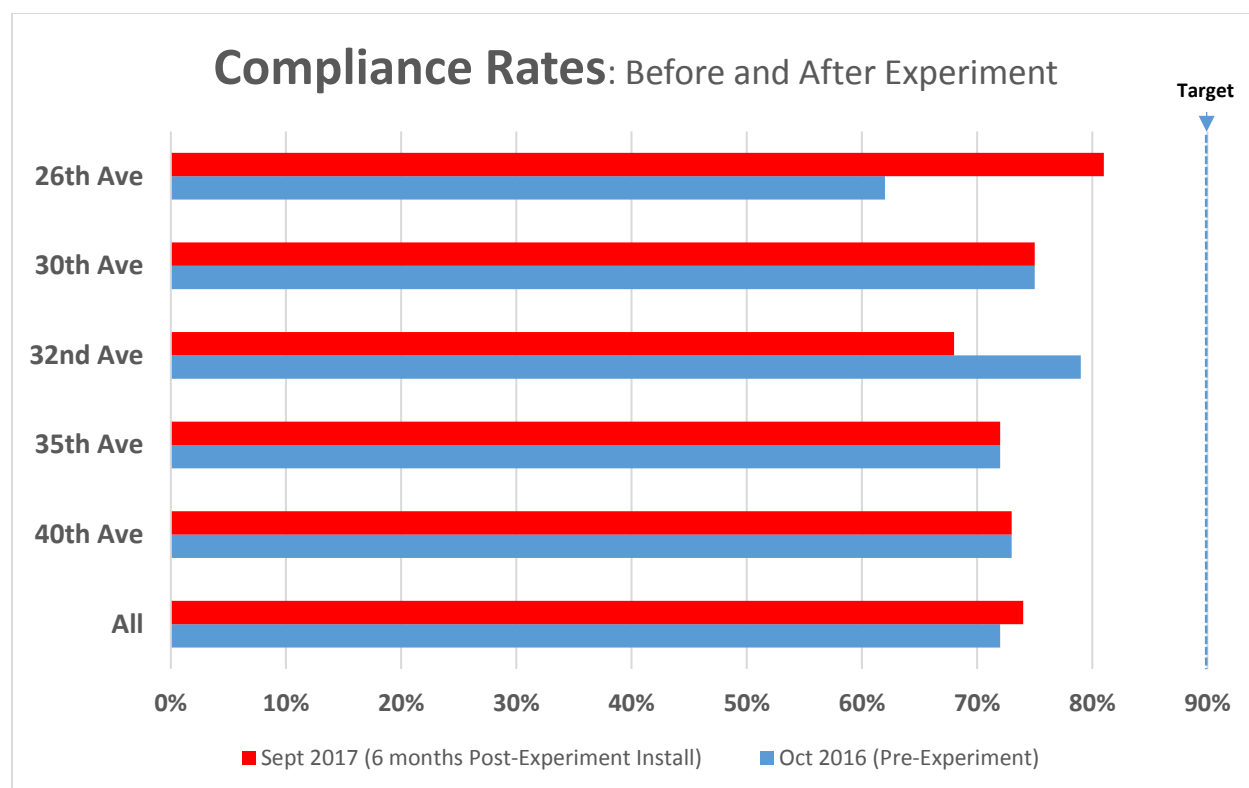


Figure 7. Compliance rate of vehicles stopped when train doors are open

The compliance rate by time of day did not show noticeable differences between the time periods of morning, midday and evening. The compliance rate was highest during the evening at 76% and was the lowest at 71% during the morning. Table 1 shows the compliance rate by time period from September 2017.

Time Period	Compliance Rate
Morning 7AM-10AM	71%
Midday 10AM-4PM	74%
Evening 4PM-8PM	76%
<b>Overall</b>	<b>74%</b>

Table 1. Compliance rate by time of day

### *Collisions*

There were no reported vehicle-pedestrian collisions involving passengers boarding/alighting train during the six-month evaluation period at the five experiment locations. There were two vehicle-pedestrian collisions at these five locations involving inbound passengers boarding a LRV between 2011 and 2016, or one on average every two to three years, thus the lack of vehicle-pedestrian collisions in a six-month period is not a statistically-significant finding.

### *Public Outreach and Feedback*

Staff engaged in extensive community outreach on the experimental treatments as part of the outreach efforts of a larger project to redesign the Taraval Street corridor. Outreach included open houses, door-to-door merchant outreach, rider outreach on trains and at transit stops, letters mailed to nearby residents and focus groups comprised of key stakeholders in the community.

After the preliminary data showed that the experimental treatments were failing to meet the target of 90 percent driver compliance, some of the key stakeholders expressed that additional measures should be added to improve driver compliance. Some of the suggestions included installing signage on a mast arm across Taraval Street, converting the pavement markings of “Transit Boarding Area” to a holographic symbol of a streetcar, and blinking lights on the roadway. These treatments were not feasible within the evaluation timeframe, but this feedback led to the addition of highly visible portable variable message signs at some evaluation locations during the final data collection period, as discussed above.

Merchants also indicated at the key stakeholders’ small group meetings that it would be helpful to distribute additional educational materials later in the evaluation period. As a result, staff distributed additional safety posters to merchants, designed to remind customers to stop for loading trains.

## Recommendations

Based on the results documented in this report, SFMTA does not recommend the CTCDC adopt the experiment to use modified signage and pavement markings as a way to improve the compliance of vehicles stopping behind an LRV stopped to board or alight passengers. The compliance rate only improved marginally to 74% with the experimental treatments compared to a 72% compliance rate before the experimental treatments were installed. The experimental treatments were offered as a quick and cost-effective solution to improve the compliance rate, but the results did not achieve a set threshold value of 90% that meets SFMTA's needs for improved safety as a permanent long-term solution.

At locations on Taraval Street that have existing boarding islands, no passengers have been injured. SFMTA staff had already made the recommendation to install concrete boarding islands in the outbound direction due to increased numbers in vehicle-pedestrian collisions. We will now recommend installing concrete boarding islands at evaluation locations as well as at any other transit stop along the Taraval Street corridor.